

# Reetik Kumar Sahu

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## CONTACT INFORMATION

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## SUMMARY

Expertise in building optimization and machine learning based frameworks for environmental sustainability problems. With a background in optimization, game theory and decision-making under uncertainty I construct decision-analysis models for water-energy nexus and common pool problems to improve sustainability.

## SKILLS

Water Resources Management, Machine Learning, Optimal Control, Game Theory, Decision-making under uncertainty, Stochastic Optimization, Numerical Methods

## RESEARCH EXPERIENCE

### **Optimization for food water energy nexus**

*Supervisor: Taher Kahil, IIASA*

*Postdoc, Dec 2020 - present*

Research projects that focus on developing optimization methods for spatially explicit solutions in water resources management issues.

- Development of a modeling and decision framework that can operate on different spatial scales
- Determining cost effective pathways towards water resilience
- Projects funded by different agencies JRC-EC, World Bank, Austrian Climate Energy
- Supervising IIASA Young Scientists Summer Program (YSSP)

### **Water Energy Decision Support using Machine learning**

*Supervisor: Juliane Mueller, Berkeley National Laboratory*

*Postdoc, Nov 2018 - Nov 2020*

This project focuses on building data-driven surrogate models using Machine learning to emulate groundwater flow in a watershed. As part of the Sustainable Groundwater Management Act in California, the project builds a decision framework for Groundwater Sustainability Managers to build resilient water management strategies

- Assess risks of future climate scenarios
- Joint project between the Computational Sciences, Data Sciences and the Geosciences group
- Funded by Laboratory Directed Research and Development at Berkeley Lab

### **Multi-Agent Real-time decision making in Water Resources Systems**

*Advisor: Prof. Dennis B. McLaughlin, MIT*

*Ph.D Project, Sep 2015 - August, 2018*

This research focuses on the numerical implementation of dynamic optimization techniques for single and multiple-agent control problems. Building frameworks to permit the use of more realistic description of the physical system that provide a better qualitative insight for decision making. With concepts from optimal control and differential game theory, two real-time decision-making problems are solved:

- Modeling groundwater pumping as a multi-agent groundwater common pool resource (CPR) problem incorporating the strategic effect of competition and aquifer dynamics
  - Obtain conditions for investment into management institutions or water markets
  - Joint collaboration with MIT economics department
  - Funded by MIT Environmental Solutions Initiative
- Developing a coupled framework for determining hydropower contract and real-time operating rules for single agent reservoir operations problem.

### **Optimal Reservoir Operation with Predictive Control**

*Advisor: Prof. Dennis B. McLaughlin, MIT*

*S.M Project, Aug 2013 - June 2016*

This project involves using Model Predictive Control (MPC) to optimize the operation of a hydro-reservoir for generating reliable hydro-power. The reservoir takes into account several competing objectives like revenue generation, environmental impacts and changing economic conditions. The work provides an insight into the impacts of energy generation for different stakeholders and suggest ways to design facilities and operating policies.

### **Parameter Estimation using Markov chain Monte Carlo class of Algorithms**

*Advisor: Prof. C. Balaji, IIT- Madras*

*Thesis project, May 2012 - June 2013*

This project was a part of an Indian government funded project, 'Swarnajayanti' to improve weather forecasting and cyclone tracking using satellite data. My work involved using Monte Carlo techniques like Hybrid Monte Carlo algorithm for parameter estimation in heat transfer problems and retrieval of atmospheric parameters.

### **Numerical study of coke deposition in tubes from rocket propellant**

*Dec 2010*

*Advisor: Assoc Prof. Amit Kumar, IIT-Madras*

This project involved the use of CFD models to simulate coke deposition in an electrically heated tube carrying rocket propellant to extract the best Nusselt number relation for predicting flow behavior. The work was presented in the 37<sup>th</sup> National International Conference on Fluid Mechanics and Fluid Power at IIT Madras in 2010.

## **RESEARCH**

### **Journal Papers**

- *Impact of Input Feature Selection on Groundwater Level Prediction from a Multi-Layer Perceptron Neural Network.* Sahu, R. K., Miller, J., Park, J., Varadharajan, C., Arora, B., Faybishenko, B., Agarwal, D. *Frontiers in Water*, 2020.
- *Surrogate Optimization of Deep Neural Networks for Groundwater Predictions*, Juliane Mueller, Jangho Park, Reetik Sahu, Charuleka Varadharajan, Bhavna Arora, Boris Faybishenko, Deborah Agarwal. *Journal of Global Optimization*, 2020
- *An Ensemble Optimization Framework for Coupled Design of Hydropower Contracts and Real-Time Reservoir Operating Rules*, S. Reetik Kumar, McLaughlin. *Dennis Water Resources Research*, 2018
- *Application of Hybrid Monte Carlo algorithm in heat transfer*, S. Reetik Kumar, B. Konda Reddy, C. Balaji, *ASME Journal of Heat Transfer*, 2017
- *Multi-scale dynamics of Groundwater Depletion*, S. Reetik Kumar, McLaughlin. *Dennis*, 2020 (in Review, *Water Resources Research*)
- *Long term Gap filling of Time Series using Deep Neural Networks*, J., Park, Sahu, R. K., Miller, J., Varadharajan, C., Arora, B., Faybishenko, B., Agarwal, D. (in preparation)

### **Conference**

- *Sensitivity of Input Feature Selection in Multi-Layer Perceptron Neural Network to predict Groundwater Level*, American Geophysical Union Conference, December 2020
- *Predicting Daily Groundwater Levels with Deep Learning Models*, American Geophysical Union Conference, December 2019
- *Managing groundwater as a common pool resource problem*, , American Geophysical Union Conference, December 2017, New Orleans, USA (poster presentation)
- *Optimal Reservoir Operation using Stochastic Model Predictive Control*, Reetik Sahu and Dennis McLaughlin, American Geophysical Union Conference, December 2016, San Francisco, USA (poster presentation)
- *Simultaneous Estimation of parameters using Metropolis Hastings and Hybrid Monte Carlo Algorithms*, ISHMT-ASME Heat and Mass transfer conference, December 2013, IIT Kharagpur, India
- *Numerical study on coke deposition in an electrically heated tube carrying liquid hydrocarbon rocket propellant*, Anurag K., Reetik Kumar Sahu and Amit Kumar, 37th National and 4th International Conference on Fluid Mechanics and Fluid Power, December 2010, IIT Madras, India

### **Talks**

- *Data for Groundwater Sustainability*, Water Data Summit: California Data Collaborative, August 2019
- *Common Pools and Water Markets*, MIT Environmental Solutions Initiative, April 2017

- *Optimal Reservoir Operation using Model Predictive Control*, MIT Energy Night, October 2016

## EDUCATION

- Massachusetts Institute of Technology**, Cambridge MA, 2015-2018  
 Doctor of Philosophy (Ph.D.) in Computational Science for Resource Engineering  
 Department of Civil and Environmental Engineering  
 Cumulative Grade Point Average (GPA) : **4.8** on a scale of 5
- Massachusetts Institute of Technology**, Cambridge MA, 2013-2016  
 Master of Science in Computation in Design and Optimization (CDO)  
 Cumulative Grade Point Average (GPA) : **4.8** on a scale of 5
- Indian Institute of Technology Madras**, Chennai, India 2008-2013  
 Bachelor of Technology in Mechanical Engineering  
 Master of Technology in Energy Technology  
 Cumulative Grade Point Average (CGPA) : **9.04** on a scale of 10

## TEACHING EXPERIENCE

- **Guest lecturer**, Water Resource System (1.731), *MIT*, 2016
- **Teaching Assistant**, Design and Optimization of Energy Systems (ME 6280), *IIT Madras*, 2013

## FUNDING

- Lab Directed Research and Development (LDRD) research grant, Berkeley Lab 2020
- MIT Abdul Latif Jameel World Water and Food Security Lab (JWAFFS), 2017
- MIT Environmental Solutions Initiative Seed grant, 2016
- MIT Schoettler Scholarship fund, 2015

## PROFESSIONAL EXPERIENCE

- Green Design Energy Systems, Chennai, India** (intern) *Summer 2012*  
 This project involved designing a **refrigerant based** solar tracking system at a household scale to mitigate the energy demand during the summer. Such systems are passive systems that do not have a parasitic power making it suitable for areas that are cut off from the grid.
- FLSmith & Co India Pvt. Ltd, Chennai, India** (intern) *Summer 2011*  
 As a part of the research division this work involved developing a heat transfer model for the ring feeder used in a cement manufacturing plant using MATLAB. I also developed a model to roughly estimate the loads and rated life of bearing without using expensive computation.

## EXTRA CURRICULAR ACTIVITIES

- **Fellow**, MIT Graduate Student Leadership Institute, (Cohort 4) *Fall 2017*
- **MIT Water Club:**
  - Director of MIT Water Night, (*March, 2017*)  
 With 200+ attendees MIT Water Night is a research showcase event where students and research groups in and around Boston area are invited to present their latest work in water-related field.
  - Director of MIT Water Summit: '*Thriving with Change*' , (*Nov, 2015*)  
 Annual flagship event of the Water Club inviting leaders from academia, finance, industry and government to discuss issues and solutions around water resources.